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AUTHOR Kerchner, Charles; And Others
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ABSTRACT

The early stages of a microcomputer-based project to integrate managerial knowledge and practice are described in this report. Analysis of the problem-framing process that effective principals use to reduce complex problems into more manageable ones forms the basis of the project. Three cognitive-mapping techniques are used to understand the managerial decision-making process: questioning, organizational data, and participant descriptions. An interactive computer system of hypermedia organizational information was developed from analysis of problem-framing accounts of five business and education managers participating in a seminar. A conclusion is that the program's use of interrelated facts to cross-reference information and ideas enables school leaders to analyze hypothetical questions about the potential organizational effects of a given development. The interactive computer system and its applicability to educational leadership is described. Two figures are included. (31 references) (LMI)

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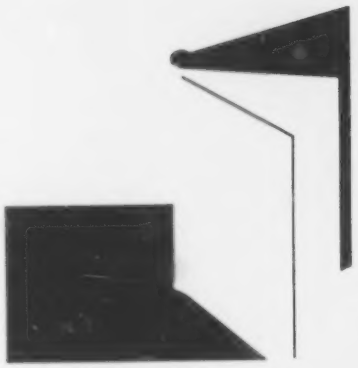

The Reflective Macintosh: A Computer-Assisted Approach to Understanding and Improving Managerial Practice

Charles Kerchner, Ross Barrett, and Byron King
Claremont Graduate School

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The National Center for School Leadership

Project Report

University of Illinois at Urbana-Champaign

University High Laboratory School

In collaboration with

The University of Michigan

MetriTech, Inc.

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Our objectives are to produce new knowledge about school leadership and influence the practice and preparation of school leaders. Through various research programs and dissemination activities, we aim to give school leaders effective strategies and methods to influence teaching and learning.

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Center staff

Russell Ames, Director
Martin Maehr, Co-Director
Stephanie Parker, Assistant Director

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The National Center for School Leadership
University of Illinois at Urbana-Champaign
Beckman Institute for Advanced Science and Technology
405 N. Mathews
Urbana, IL 61801
(217)244-1122 Fax number (217)244-4948

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Charles Kerchner
Professor, Education and Public Policy
Claremont Graduate School

and

Ross Barrett
Byron King
Claremont Graduate School

Abstract

How do effective managers think? This remains the most important question facing those working to improve school leadership. This paper describes the early states of a microcomputer-based program designed to aid in understanding the tacit knowledge encased in an effective leader's instinctual behaviors. The program was developed by analyzing the framing process that effective principals use for reducing extremely complex social problems into more manageable ones; it can be thought of as a group of file cards which are interrelated in a variety of ways. By allowing school leaders to cross reference information and ideas using interrelated facts, this program enables them to ask, and answer, hypothetical questions about the effect a given development might have on their organizations--just as business managers are able to investigate the financial ramifications of various decisions. With such tools, the power to engage in a substantive rethinking of school structure, performance, and capacity, is passed to the people actually doing the work.

The Reflective Macintosh: A Computer-Assisted Approach To Understanding and Improving Managerial Practice

Understanding practice is tightly tied to the problem of improving it. In film, theater and dance, we intuitively connect understanding and improvement. Practice and improvement revolve in a tight loop, created by the intercession of a director, coach, or choreographer. Thought and action are comfortably simultaneous. But in occupations, such as management, where effective performance is less visible, the connection between understanding practice and improving it is more tenuous. This chapter describes the early stages of a microcomputer-based project to tighten the linkage between understanding managerial practice and improving it.

Efforts at improving managerial practice are most frequently associated with increasing the manager's analytic capacity. And, since the social science revolution a generation ago, it has been commonly believed that the practice of management would be

improved if managers thought more like statisticians, systems analysts or financial planners...or if they just thought more. However, over the last generation, increasing attention has also been paid to how managers actually behave and how they think. Mintzberg (1973) drew a picture of organizational life controlled by clock and calendar and informed by visual and verbal cues rather than the formal management information system. Allison (1971) dramatized how decision makers frame problems. John Kennedy, Robert MacNamara, and the other participants in the 1962 Cuban Missile Crisis perceived the event from different perspectives, and their conceptual frames colored how solutions were valued and what actions were considered.

In the two decades since these two books were written, the idea of different world views and approaches to problems became a standard in how we talk about organizations and teach about them. A master's student in business administration or a candidate for administrative certification in education will commonly learn the language of frames and framing: What does this look like as a political problem? What are the

structural implications? Where's the cultural dimension in all this?

Various authors use different terms to describe the phenomena of processing organizational information: frames, schemas, and theories-in-use. Bolman and Deal (1984, p. 4) use the word frames to describe the way in which one perceives the organization:

> Frames are windows to the world. Frames filter out some things while allowing others to pass through easily. Frames help us to order the world and decide what action to take. Every manager uses personal frames, or images of organizations, to gather information, make judgements, and get things done.

Schemas are defined by Lord and Folti (1986, p. 22) as a "cognitive structure that represents organized knowledge about a given stimulus--that is, a person or situation--as well as rules that direct information processing." This serves as a "guide for the interpretation of information, actions, and expectations."

Schön (1983) points out that when individuals use schemas to adjust their behavior to those of others within the organization, a theory-in-use is created. If generalized, the theory becomes a part of the organizational culture or value system, separate from any specific individual, and defines the organization's way of doing and knowing.

The advantage of frames, of course, is that they expand the ways to comprehend an organization's behavior and bring understanding to very complex situations. "Organizations exist largely in the mind, and their existence takes the form of cognitive maps. Thus, what ties an organization together is what ties thoughts together" (Weick & Bougon, 1986, p. 102). Frames also restrict; they "filter out some things while allowing others to pass through easily" (Bolman & Deal, 1984, p. 4). However, problem analysis using frames also allows the viewer multiple vantage points. If the axiom, "I'll see it when I believe it," is accurate, then the multiple-frames approach to decisions provides us with a much richer picture of organization and management than do either an assumption of a single type of rationality

or static principals of organization deduced from practice. As Bolman and Deal put it, "When we introduce the four frames, people often respond with initial confusion. The frames seem to contradict one another; there is no right answer" (1984, p. 7). Yet, in some way, the experience of framing appears to help understanding, the development of effective alternatives, and the avoidance of nasty surprises.

Frames function as a "cognitive economy" (Gioia, 1986, p. 55), a prefabricated organizing system that helps managers make sense of uncertain situations. Frames allow integration of the present with a known past, turning the ambiguity of the present into a variation on an already understood experience. Schön maintains this cognitive connection is necessary for management to function at all. "The practitioner does not consider that he has formed a satisfactory account of phenomena in any practice situation until he has framed it in terms of his overarching theory" (Schön, 1987, p. 273-274). At the least, framing appears to help managers function well. Leithwood and Stager (1986, p. 28) found that highly effective principals

have found relatively simple 'macro' procedures for reducing extremely complex social problems to more manageable ones.

But as useful as they are, prefabricated frames tell us relatively little about how managers actually think about organizations: how they inform themselves, process information, and integrate thought and action. Frequently, though, they do not have a language system to tell others what they know. The art and craft of administration are shot through with what Polyani calls "tacit knowledge," a fact recognized by Chester Barnard, who wrote about "the skillful judgments, decisions, and actions we undertake spontaneously, without being able to state the rules or procedures we follow" (Schön, 1987, p. 24). When they try, they frequently end up with by saying, "Well, you just kinda know."

The techniques of cognitive mapping are designed to concretize the tacit knowledge encased in "you just kinda know," and the project we are developing makes use of some of these techniques. Three techniques commonly are used in creating cognitive maps: 1) systematic coding of documents representing the writings or

statements of an individual, 2) eliciting causality beliefs through questionnaire and interviews, 3) coding of verbatim transcripts of private meetings in which the individual participates (Weick and Bougon, 1986, p. 113).

Hall's (1976) research into the last years of the Saturday Evening Post relied on systematic coding of organizational documents to show a closed loop of assumption and thought that went unrecognized. In an era of rising production costs, the magazine lowered subscription rates to build subscribers even though having more readers led to lower advertising rates per reader, which attracted more advertising pages, which, in turn, increased production costs.

Bougon, Weick and Binkhorst (1977) provide an example of an observation/questionnaire approach to framing. They showed how the 19-member Utrecht Jazz Orchestra made decisions with very little hierarchical or decisional structure. Lotto and Murphy (1988) used a similar technique with school administrators.

Argyris and Schön's (1978) technique, which underlies Schön's later work on reflective practice

(1983, 1987), uses transcripts from participant descriptions of decisions while simultaneously noting the intentions of their actions. The transcripts reveal how an individual has framed a problem and the data elements being used.

Cognitive maps date at least to Goodman's (1968) attempt to operationalize Kurt Lewin's ideas about psychological force fields although the term was used by Tolman (1948) in discussion of learning in laboratory animals and humans. Maps are means-ends connections, and, unlike a statistical path analysis, they generally allow loops or circles in which thought, action, or information feed back on one another. Over the last few years, mapping has become increasingly used in research into management. Aldag and Stearns (1988) review recent applications: organizational politics (Jones, 1986), information requirement analysis (Montazemi and Conrath, 1986), strategic scenario building (Eden, William & Smithin, 1986), and complex problems (Bennett, 1985).

In the subsequent sections of this paper, we develop the outlines of a framing and cognitive mapping technique designed to close the circle between

understanding what managers do and providing substantive assistance in working on problems. We draw from the tradition of problem framing. The, still-embryonic technique uses all three techniques associated with cognitive mapping: questioning, organizational data, and participant descriptions. Our goal is to use problem framing as a type of experiment. It is our hope that the process we are developing will allow managers to ask "what if" within the social context of their organizations just as spread sheets facilitate exploring financial alternatives.

Conversations with Managers

Our progress toward this computerized application begins with a series of distinctly non-machine conversations. Over the 1988-1989 academic year, Ross Barrett and John Regan of The Claremont Graduate School initiated a seminar of business and education sector managers to test the proposition that reflection could aid practice. We asked each of five participants to develop a case involving a difficult decision, perhaps one that did not go well. In one case, the manager's

decision and subsequent actions yielded superb results when tried the first time and failed in the second application.

The procedure was straightforward:

1. The manager wrote a brief case,
2. expanded upon it in the seminar and answered questions--
3. all of which was tape recorded, transcribed, and analyzed.

From this initial process, we drew six lessons that are being applied to the computer-based scheme. First, we found that the managers worked within a frame or cognitive scheme. In order to talk about the events they were describing, they always relied on an abstract conceptualization. However, the frames did not seem abstract to the presenters. Probing questions during the seminars revealed that the framing occurred during the process of acting on the problem and that the labels seemed very real and natural. The act of framing may have been a prerequisite to the practitioner taking action at all. One of the seminar members offered this example:

A labor lawyer receives a call from a client whose plant has just been hit with a wildcat strike. The client wants advice now. The labor lawyer (like every professional) can recite at will the particular legal regulations which bear on this work stoppage. What he cannot do so readily is evaluate the economic and psychological factors which will influence both sides in this dispute. This is where reflection-in-action must occur by both lawyer and management:

--How long can the company afford to take a strike?

--How easy will it be for striking workers to get another job?

--How easy will it be for the company to bring in non-union workers?

--How strong is the union leadership?

--How tough is management?

In order to develop this example, the seminar member had to put the strike into a frame, either psychological or economic. One frame had to be dominant, in this case, economic. Moving forward

required some structure. We rediscovered the knowledge of practice possessed by Schön's architecture studio master who said to a student, "You should begin with a discipline, even if it is arbitrary, because the site is so screwy--you can always break it open later" (Schön, 1987, p. 49).

It is within the chosen frame, that the incomplete data on the strike situation are analyzed. The practitioner's experience and the beginning framework serve as a "guide for the interpretation of information actions, and expectations" (Lord and Folti, 1986, p. 22). The attorney's questions of the client fall within the chosen frame:

--Will customers be helpful by trying to delay purchases until the strike is over, or will they immediately switch to competitors?

--How much production can be maintained by supervisory personnel?

--How quickly (if at all) can non-union labor be brought in?

--Will creditors cooperate by extending time for debt payments?

The attorney's assumptions may be right or wrong, but making them allows forward movement.

Second, we found that the seminar participants' thoughts fell rather comfortably within the four frames developed by Bolman and Deal (1984): structural, political, human relations, and symbolic. While none of the practitioners was schooled in Bolman and Deal's work, their descriptions elicited comments that the frame constructions were robust and realistic.

Third, participants in the seminar moved between frames or appeared to integrate elements of one frame into another. An elementary school principal described the development of a reading program for his school as a pedagogical problem. Teachers and the principal spent months reading about different approaches and discussing the idea among themselves. They ended up with a relatively simple structural solution: reduce the number of ability levels for which each teacher was responsible and allow the children to travel between rooms.

The principal described a year-long process of meetings among teachers and with parents: the things they had read and considered, how the principal had taught classes to free teachers to meet, and how parents had evening meetings in their homes. It was apparent that enormous energy had gone into the process and that the decision was generally well received. In presenting the case, the principal essentially congratulated himself on making a sound educational decision.

However, discussion revealed a wholly new aspect to the case. Someone asked about the origin of the idea to divide reading groups differently. The principal replied that he had the solution in mind all along. Another member of the seminar, a business executive, raised his hand and eyebrow simultaneously and with a quizzical look said, "David, why didn't you just tell the teachers what to do and save all the fuss and bother?"

The reply revealed both the interpersonal and political dimensions of the case. David, the principal, knew that he had no effective way to gain teacher compliance by telling them to change the reading

groupings. He understood that teachers, or complaining parents, could undo a simple order. David needed the teachers' engagement in the new plan, not just their compliance with a directive. Additionally, he understood that the new reading grouping was not just a single decision--divide the children differently--but that there were scores of small adjustments that had to be made. No order from the principal could cover the contingencies.

David had sublimated the political dimension of the case all along, so much so that he did not consciously label his thoughts or actions as "political."

Fourth, we found that the participants did learn from their own experience. As in David's case, reviewing the incident brought out information that might not have come through during the actual experience. The reviews strengthened recall and stimulated reframing. One participant wrote, "It pains me to admit it, but when the actual events were occurring, I had deluded myself into thinking the basics (in the two cases) were quite similar. I gave an inordinate amount of province to the personality clash

with [X] (which was later revealed to be only part of the difference between the two cases)."

Fifth, even though learning took place, our participants also exhibited elements of what Argyris and Schön (1978) call "self-sealing" behavior in which information contradictory to the original frame was not recognized, discounted, or could not have led to a change in action.

This underscores the need for what Argyris and Schön (1978) call double loop learning. Single loop learning transpires when one reflects on experiences, changing behavior as a consequence of a mismatch between what one wanted and what one got. This strain of learning from nature is traceable back at least to Dewey. But some problems are not so easily solved and require examination and alteration of basic governing variables. History, experience, and the dominant frame are difficult to discard even when analysis tells one that they should be. Defensiveness and face-saving block movement toward new solutions and capture participants in error-escalating processes. Removing oneself from undesirable cause/effect relationship

requires both intellectual understanding and allowing oneself to take on new behaviors.

Sixth, the frames don't provide much guidance about which one is correct. Some frames, some data, and some conditions are more important than others. Brilliant military tactics can win battles, but tactics are only partially substitutable for gunpowder and gasoline. A good curriculum may be important to student achievement in schools, but (as many administrators have learned painfully) the official curriculum is subject to enormous redefinition by the student and teacher culture. If we are to use technology to create "standard operating procedures that are smarter than we are," (Weick, 1979, p. 70) then we will have to find ways to combine complex and powerful tacit knowledge with the analytic perspectives on influence.

The Interactive Computer System

The computer routine under design and development is intended to be both friendly and interactive: a petting zoo of organizational information rather than an analytical answer machine. The routine will make full

use of the information storage, retrieval, and manipulation structure inherent in what is known as "hypermedia."

> In broad terms, hypermedia is the delivery of information in forms that go beyond the traditional list and data base report methods. More specifically, it means that you don't have to follow a predetermined organization scheme when searching for information. Instead, you branch instantly to related facts (Sculley, 1988).

User control and the ability to move from fact to fact in response to self-perceived needs for additional data make hypermedia an attractive tool to explore the administrative process in schools. As a word, and an idea, hypermedia is emerging from the specialized language of computer developers into the realm of applications in business and education.

Hypermedia is particularly valuable in establishing a context for any given data element, or allowing the user to construct a context. For example, one of the popular applications links hypermedia to a laser disk holding thousands of images from the National Gallery of

Art. The user is free to electronically browse the galleries, concentrate on a particular period or artist, and access the biographies of schools of painters. A high school teacher in San Francisco has built a cultural history project around Steinbeck's Grapes of Wrath in which the book is linked to the sociology, politics, and economics of the 1930s.

The popularization of hypermedia has been aided greatly by capacity expansion in microcomputers: large disk drives, the connection to laser storage devices, and software which makes writing applications easier. HyperCard, developed for the Apple Macintosh, is the most popular of the hypermedia software, and it is the tool we are using.

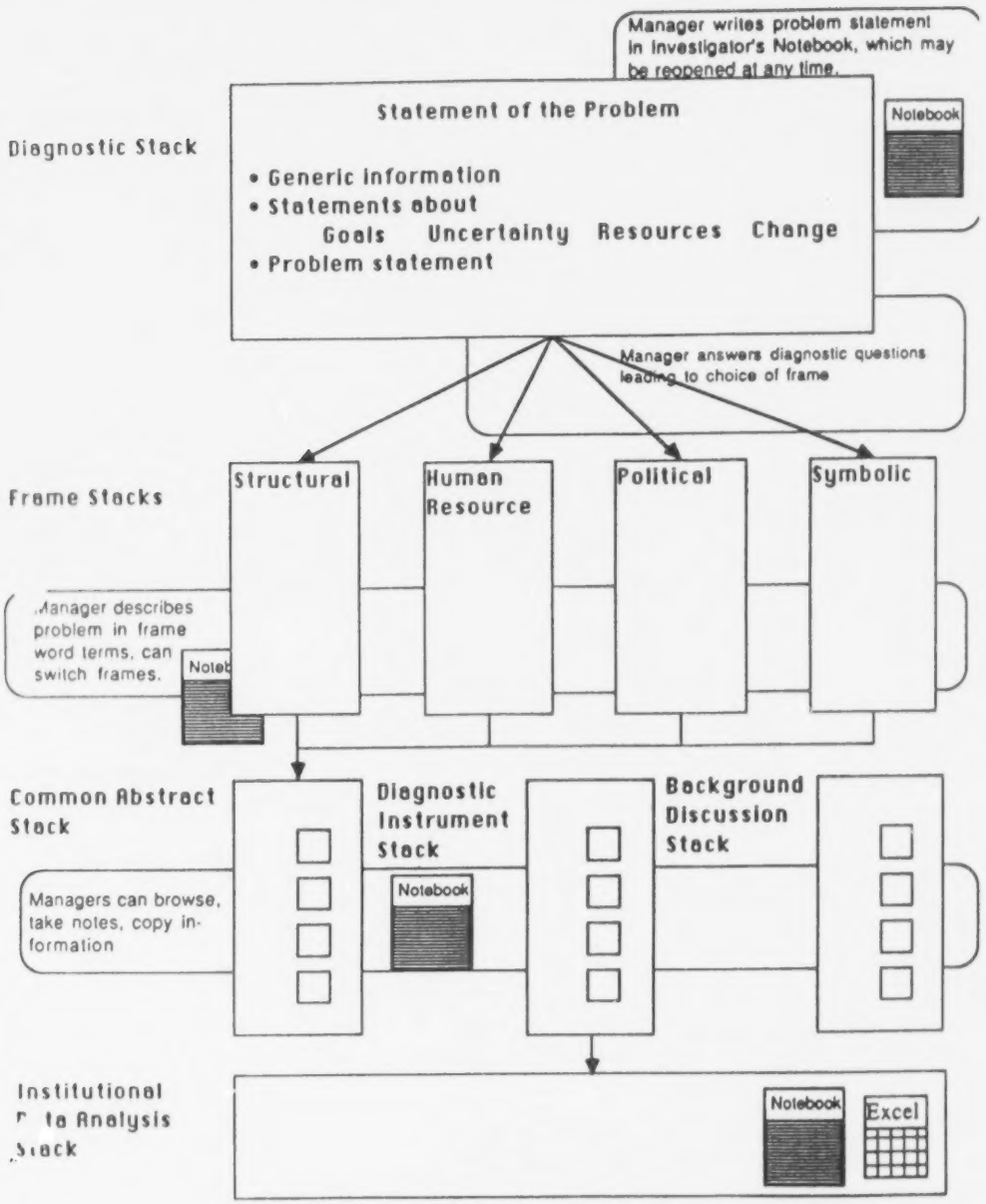
HyperCard can be thought of as a series of file cards placed in stacks. (Physically, of course, HyperCard information is electronically stored and bears no resemblance to file cards, but the image of cards and stacks is a convenient way to conceptualize the system.) As shown in Figure 1, the organizational framing program under development is organized in four types of stacks:

- Diagnostic stacks designed to allow the user to enter basic organizational information, and to write an initial statement about the problem.
- Frame stacks designed to ask questions and provide responses to organizational questions that occur within four approaches to organizational problems: structural, human resource, political, and symbolic or cultural.
- Information stacks, which include abstract and bibliographic material, sets of diagnostic instruments which users might apply to investigations of their organizations, and background information stacks on organizational thought and theory.
- Data Analysis Stacks that incorporate linkages to spreadsheet programs, such as EXCEL, allowing users to undertake analysis of information that can inform the reflective practice activity.

What we have called "The Investigator's Notebook" comprises the last element on the system. Figure 1

Figure 1

Structure of Computer System



shows the notebook symbol in several places, indicating that it can be used at any time during the reflective practice exercise. The Investigator's Notebook is the managers' work space. They can return to it from any stack in the program, they can take notes at any time, record thoughts, and transfer information from the program stacks into the notebook. The notebook establishes an historical record to interactions with data, other persons and questioning probes, and it establishes a individual or work-group property space within the system. Figure 2 shows a sample page from the prototype notebook. The authors used the notebook device to communicate with one another during the preparation of this chapter, and the text, which is simply an example, is a series of words associated with particular frames.

The Diagnostic Stack

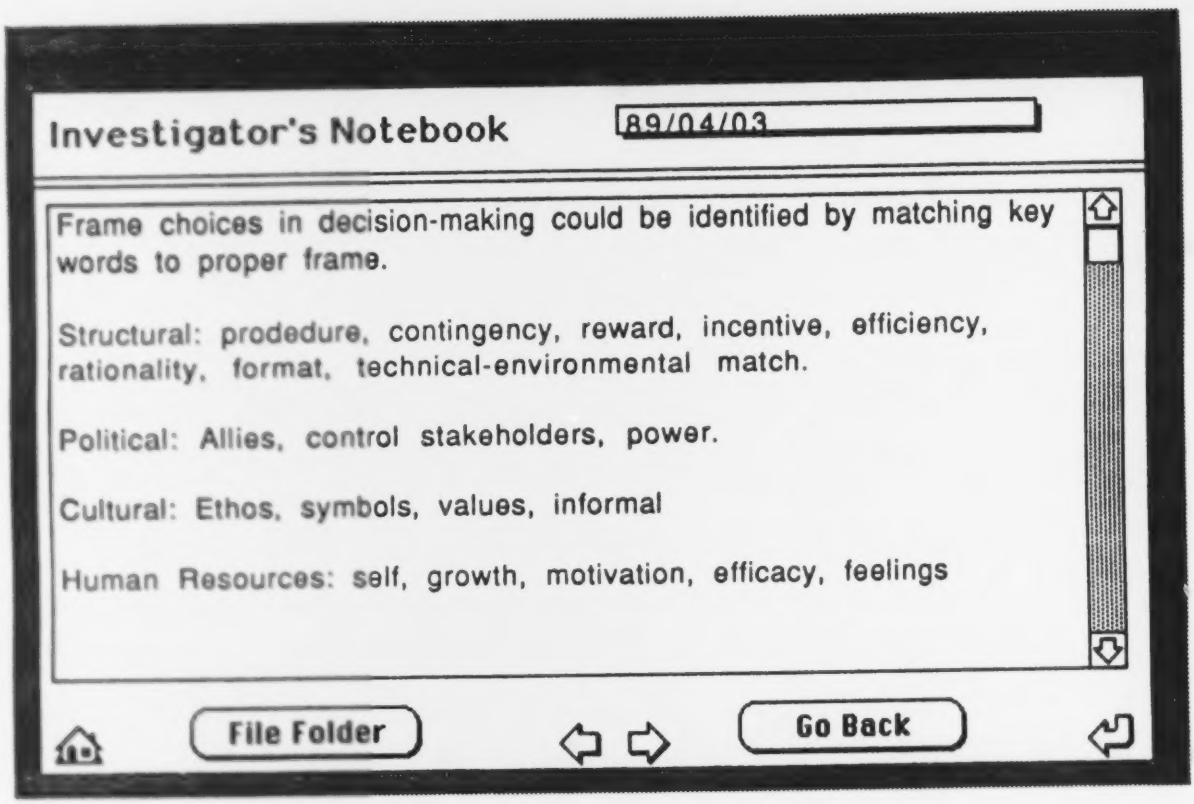
One enters the system through a Diagnostic Stack. Managers are asked for three different types of information, which serve to cue the system. First, they respond to a series of introductory queries for basic, generic information about their organization. These

queries have largely been gleaned from the literature on organizational diagnosis (Levinson, 1972; Weisbord, 1978, 1987), including:

1. Basic Structure and Size Information:
    a. Enrollment
    b. Number and type of schools
    c. Total employees: classroom teachers
2. Financial Information
    a. Total operating budget
    b. Comparisons with surrounding districts
    c. Recent financial trends and projections
3. Political Information
    a. Size, composition, and tenure of school board
    b. Tenure of superintendent
    c. Recent electoral history
4. Performance Information
    a. Standardized measures
    b. Other indicators

Figure 2

Investigator's Notebook


Investigator's Notebook
89/04/03
Frame choices in decision-making could be identified by matching key words to proper frame.
Structural: prodedure, contingency, reward, incentive, efficiency, rationality, format, technical-environmental match.
Political: Allies, control stakeholders, power.
Cultural: Ethos, symbols, values, informal
Human Resources: self, growth, motivation, efficacy, feelings
File Folder
Go Back

The object of these questions is to obtain a quick first impression of the district or school. The computer will analyze questions such as organizational size and financial status as a way of feeding back information to the user. The information will be automatically transferred to the Investigator's Notebook. As the program becomes more sophisticated, it will enable managers to gain an initial comparison between their organization and similar ones. For example, the system might hold comparative achievement information, data on political stability of schools, the ages and experience levels of staff, or comparative fiscal reports.

Second, managers are presented with several diagnostic questions concerning: 1) organizational goals, 2) uncertainty in the organization's environment, 3) extent of slack resource, and 4) the rate of change facing the organization. The answers to these questions are analyzed as a way of directing managers to a particular frame for further exploration.

The nature of organizational goals, for example, provides clues about what frame is likely to fit current

problems. The structural frame nearly always assumes relatively clear, widely accepted goals. Political analysis is called for when goals are unclear but when there are strong voiced preferences and signs of organization around different preferences. Unclear goals may also signal the applicability of a symbolic approach to organizational functioning, but in this case preferences as well as goals are often weak or unclear--a collection of solutions looking for problems (Cohen and March, 1974).

Initial diagnostic questions assess goals in terms of the four dimensions:

1. How clear are this organization's goals?
2. How universal are they?
3. How strongly held?
4. Are there identifiable groups or individuals with different goals?
5. Is there apparent tension between groups or individuals with different goals or do they seem to coexist comfortably.

Similar questions are asked about uncertainty, slack resources, and change. The decision about which

frame to enter is based on an analysis of the initial diagnostic questions by roughly following this scheme:

	Structural/Human/Political/Cultural Resources			
Goal Clarity	+	0	-	-
Enough Resource	0	+	-	0
Certainty	+	0	-	-
Change	-	+	+	+

A plus (+) indicates that the presence of the characteristic in question indicates the applicability of that frame, a minus (-) that the absence of the particular characteristic indicates the applicability of that frame, and a zero (0) that the characteristic is not particularly important to association with that frame. For example, as the goals of the organization become clear and certain, the structural frame is more likely to fit problem analysis while the political and cultural frames diminish in importance. This arrangement, drawn from Bolman and Deal (1984, p. 236)

serves as an initial way to lead managers into a frame of reference.

The third and final diagnostic task that the managers are asked to undertake is to develop their own problem or case statement. The statement, which is stored in the Investigator's Notebook, becomes the initial stage in the reflective process. As the process continues, the manager may modify the problem statement, add to it in light of additional information or analysis, or raise questions for subsequent exploration.

The computer routine will assist reflection by analyzing the cases, by finding words or phrases that frequently have meaning within one or more analytical framework(s), and by directing attention to those items.

The Frame Stacks

Based on answers to the diagnostic questions, the computer moves to one of the four frame stacks. The computer then analyzes the initial case statement text, looking for matches between words used in the case statement and a small dictionary of words that has particular meaning within that frame. For example, within the political frame, the computer might look for

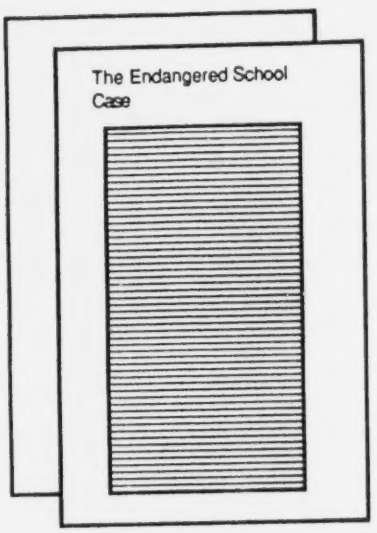
words such as "influence," "power," or "conflict." Figure 3 shows a prototype of such a display in which managers are asked to choose the words that are most and least important to the case they are developing. In order to arrange the words according to levels of importance, managers will electronically move the word from the list at the top of the screen into one of the boxes at the bottom. The reader may recognize the similarity between this procedure and that of the Q-Sort technique. The sorting system approximates a normal curve, allowing only a limited number of words to be classified as most or least salient.

The words which end up in the right hand columns are perceived most important, and the computer will use them in opening up areas within the frame for further investigation. Some words, "conflict" is a good example, have somewhat different meanings in different frames and might prompt queries asking the writer to amplify the case statement.

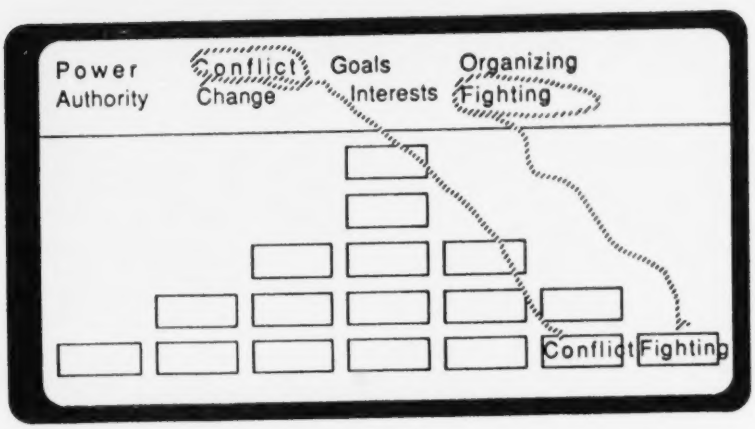
For example, if the top priority words had to do with organizational cultures, the manager would be

Figure 3

Scheme for Word Analysis From Case Statement



Computer analyzes text of case statement written by manager. Matches words in case with those in a dictionary of words that have meaning within each frame of analysis. Then, the computer presents a display similar to the one shown below.



presented a screen inviting them to undertake a cultural audit. Then they would be free to seek information from the literature, to look at diagnostic instruments, or to read background discussions relating to their area of interest.

Information Stacks

Each frame stack contains information central to the concepts associated with it. For example, the political stack includes reference to coalitions, power, and organized conflict. In turn, each frame stack is linked to citations in the Information Stacks. These stacks serve as reference points to the literature and research materials on organizations, but, unlike a conventional bibliography, this literature is presented within the context of problems which managers construct for themselves. Instead of the usual "great books" list, managers are able to obtain readings that pertain specifically to their interests.

The Reference Stack contains bibliographic information associated with the ideas introduced in each frame stack. If one were interested in coalitions, for instance, a term found in the political stack, one could

open a series of references and move to abstracts of each. The inquirer might find citations to the work of Caplow on coalitions in triads, Schattschnieder on political cleavage points, or a review of Cyert and March's ideas on dominant coalitions' effect on organizational decision-making. Each of these ideas has applicability across frames and, thus, has the utility of extending the cognitive into more than one frame.

The Diagnostic Instrument stack holds the key to following the initial problem statement with inquiry into one's own organization. One of the most empowering of acts lies in being able to understand one's own practice, and tying ideas and problem statements to a ready catalog of instruments provides a means to this end. Price and Mueller (1986) provide a wide range of organizational instruments. Institutional inventories, such as the Institutional Climate Inventory and the School Administrator Assessment Survey (MetriTech, 1988), are available from several sources. Weisbord's (1978) organizational diagnosis scheme contains a score of instruments, and the series of yearbooks produced by University Associates contain several hundred.

For those who wish more detailed inspection, the Background Information stack would contain readings on key subjects. The memory requirements of such a system might easily outrange microcomputer capacity, and so eventual connections to laser disk technology and bibliographic services, including ERIC, are anticipated.

Because of the data collection required, interaction with this stack may well take on the characteristics of a project rather than a one-time reflection. The computer system's structure will make repeated interactions easier because the Investigator's Notebook provides a continuing record of progress. The system would be also amenable to use by teams of managers.

Data Analysis

The final structural element is the Institutional Data Analysis Stack. The purpose of this stack is to merge reflection and intuition with the ability to try out alternatives within the scope of an organization's own information. The stack is linked with a spread sheet program (in this case Microsoft EXCEL). As with each of the other stacks, managers are free to enter and

work within or omit the stack from their work. Obviously, the investigations to be carried out in this stack imply a detailed analysis and more metric data than may be present in some cases. Information from the Diagnostic Instrument Stack can be moved into this stack and operated upon in spread sheet form. Managers can also gather and operate on other information as they wish. Still, they are free to move back and forth between the spread sheet and the Investigator's Notebook, or back into the other stacks.

Information from the Diagnostic Stack could be transferred to the Data Analysis Stack that could, in turn, call on a sophisticated spreadsheet program such as EXCEL. Substantial analytic power would be built into the Data Analysis Stack through the use of programs that structure spreadsheet operations (EXCEL calls these "macros"). Some of these are already under development. The Coalition for Essential Schools, for example, is developing a series of macros that allow easy testing of alternative schedules, budget allocations, and staffing assumptions.

With such techniques, the power to engage in substantive rethinking of school structure, performance, and capacity are passed to the hands of people actually doing the work. Much of what the American statistician W. Edwards Demming taught Japanese industrialists is captured in the symbolic impact of data. Placing straightforward data analytical power in the hands of managers and workers helps build consistency of purpose, drives out fear, and introduces empowerment and self-worth. The techniques involved are straightforward. Demming's graphics, used throughout Japan and conspicuous on the shop floor at joint Japanese-American enterprises, involve techniques familiar to social scientists but relatively rarely used in school planning and analysis. Cause-and-effect diagrams, flow charts, histograms, control charts, trend charts, and scattergrams can create substantive changes in school organizations. When workers control their own information, they open the possibility of monitoring progress and changing direction without fear or external mandate.

A Teaching and Research Tool

We believe the organizational diagnosis and reflection system under development has substantial promise for learning about practitioner thought, explicit teaching and real-time organizational problem solving, and for reestablishing the relationship between the field and the university. Penetrating the information-processing capacity of working managers lies at the threshold of our concern. If one starts with the proposition that what distinguishes professionals is not their body of certain knowledge but their ability to operate when knowledge is uncertain, then one has a beginning to the inquiry (Schön, 1987). When an engineer, for instance, needs to decide how to build a road, there are frequently good technical practices as a guide. But when an engineer faces problems of what road to build or whether to build a road at all, he or she faces an ill-defined problem. Good practitioners know how to attack such problems. Frequently, though, they do not have a language system to tell others what they know. The art and craft of administration are shot through with tacit knowledge.

As a teaching instrument, the system would work superbly with case-or field-generated problems. It presents information about organizations in a natural way, in response to problems, rather than as an abstract set of concepts. Managerial novices, new administrators, and lead teachers could immediately apply what they already know about schools, and could have available a substantial amount of information "on demand." Readings and class discussions could be problem based and yet conceptually connected. The system invites curiosity, welcomes browsing, and is hospitable to complex and creative thinking about problems. It is the antithesis of The One Minute Manager.

The same system could be used with experienced managers reporting on difficult, complex problems. They could use the system, perhaps making very little use of the background and framing provisions, to present information. The computer system could be used as a means of providing the necessary double looping, asking managers to reconsider assumptions they made along the way, seeking reflection. Indeed, the system could be

used within the confines of the more traditional reflective practice techniques of Argyris and Schön (1978).

Over the past 20 years, an odd relationship has formed between public schools and universities. Faculties in elite, research-oriented universities began to study education rather than do education, and in a curious way, the social distance between the university and the schools became a hallmark of high status among education graduate programs. In the words of one assessment, the message in the graduate schools of education is: "Do not prepare teachers or school personnel or educational administrators. No credit will come to us for dealing with schools that are messy or difficult" (Judge, 1982). University schools of education were selectively trained to discouple from the same field of practice that they were established to forward.

The problem of practitioner knowledge is quite different from the problem of academic knowledge, or strictly speaking the problem of science. There are two primary differences. One difference has to do with the

availability of experimental conditions--explicit hypothesis, formal modeling, and randomization. The second difference has to do with an exclusively detached research role in which the "truth-seekers" have no direct interest in the outcome of the experiment. Experimental conditions seldom exist in organizations, and managers are far from detached observers. The knowledge they gain about organizations is both learning by doing and learning while doing.

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About the Authors

Charles Taylor Kerchner is professor of education and public policy at The Claremont Graduate School. He directs the program in school administration and conducts research into human resources management and school reforms.

Ross Barrett is a retired business executive and visiting scholar at CGS. During the last 25 years of his career, he was a divisional president and senior corporate officer of Metromedia, Inc.

Byron King is a teacher assigned to the race/human relations staff of the San Diego City Schools and a doctoral student at CGS.

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Marilyn Rauth
Director, Education Issues, American Federation of Teachers

Laraine Roberts
Director, Leadership in Educational Administration Development (L.E.A.D.) Project, California

Lynn St. James
Principal, Lindblom Technical High School, Chicago

Scott Thomson
Executive Director, National Association of Secondary School Principals

Lonnie Wagstaff
Professor, Educational Administration, University of Texas at Austin

Project Investigators

University of Illinois at Urbana

Carole Ames, Chair, Educational Psychology
Russell Ames, Director, University High Laboratory School
Ellen Russell, Associate Chair, Educational Psychology
Alan Peshkin, Professor, Educational Psychology
Frederick Wirt, Professor, Political Science

University of Illinois at Chicago

Larry Braskamp, Dean, College of Education

University of Michigan

C. Philip Kearney, Professor, Education
Martin Maehr, Director, Education and Psychology
Carol Midgley, Project Associate
Karl Weick, Rensis Likert Collegiate Professor, School of Business

MetriTech, Inc.

Samuel Krug, President
Stephan Ahadi, Project Investigator
Chris Scott, Project Investigator

Illinois State Board of Education

Dianne Ashby, Program Development and Delivery

Visiting Scholars

William Boyd, Professor, Education, Penn State University
Robert Crowson, Professor, Educational Administration, University of Illinois at Chicago
Charles Kerchner, Professor, Education and Public Policy, Claremont Graduate School
Douglas Mitchell, Professor, Education, University of California at Riverside